10/619409

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patentee: Gary A. FREEMAN Issued: August 24, 2004

Patent No.: 6,781,663 B2

For: **ELECTROOPTICAL DISPLAYS CONSTRUCTED WITH POLYMER-COTATED ELEMENTS POSITIONED BETWEEN SUBSTRATES**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CERTIFICATE OF CORRECTION UNDER 37 C.F.R. § 1.322 OFFICE MISTAKE

Sir:

Transmitted herewith in duplicate is PTO Form 1050 - Certificate of Correction for the above-identified U.S. Patent correcting the Office mistake as shown in the enclosed Certificate of Correction form.

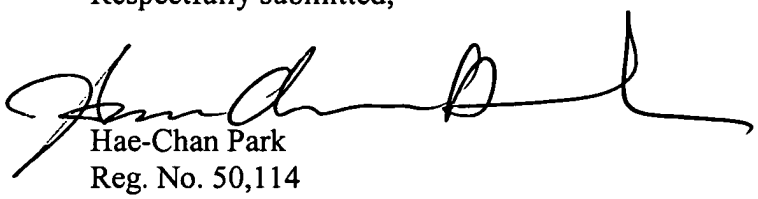
The correction for the Office mistake is reflected in the attached copy of the Specification filed July 15, 2003, with the U.S. Patent and Trademark Office.

Also enclosed is a copy of the Letters Patent, with the requested correction marked in red ink.

Since the above-mentioned matter was correctly shown in the Specification, issuance of a Certificate of Correction is in order. Since this error was due to the Patent and Trademark Office, no fee is submitted herewith.

If any error is determined to be on part of the applicants, please charge all necessary fees to attorney's deposit account no. 23-1951.

Respectfully submitted,



Hae-Chan Park
Reg. No. 50,114

Date: September 3, 2004

McGuireWoods LLP
1750 Tysons Boulevard, Suite 1800
McLean, VA 22102
(703) 712-5000

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.: 6,781,663 B2
DATED: August 24, 2004
INVENTOR: Gary A. FREEMAN

It is certified that errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below.

Column 13,
Line 8, delete "claim 7" and insert --claim 3--.

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McGuireWoods LLP
1750 Tysons Boulevard, Suite 1800
McLean, VA 22102
(703) 712-5000

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1750 Tysons Boulevard, Suite 1800
McLean, VA 22102
(703) 712-5000

FORM PTO 1050 (Rev. 2-93)

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(12) **United States Patent**
Freeman

(10) **Patent No.: US 6,781,663 B2**
(45) **Date of Patent: Aug. 24, 2004**

(54) **ELECTROOPTICAL DISPLAYS CONSTRUCTED WITH POLYMER-COATED ELEMENTS POSITIONED BETWEEN SUBSTRATES**

(75) Inventor: **Gary A. Freeman**, Newton, MA (US)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/619,409**

(22) Filed: **Jul. 15, 2003**

(65) **Prior Publication Data**

US 2004/0012748 A1 Jan. 22, 2004

Related U.S. Application Data

(63) Continuation of application No. 09/882,311, filed on Jun. 15, 2001, now Pat. No. 6,621,548.

(51) **Int. Cl.**[7] **G02F 1/1339**
(52) **U.S. Cl.** **349/155**; 349/187
(58) **Field of Search** 349/155, 156, 349/157, 183, 187, 190, 86

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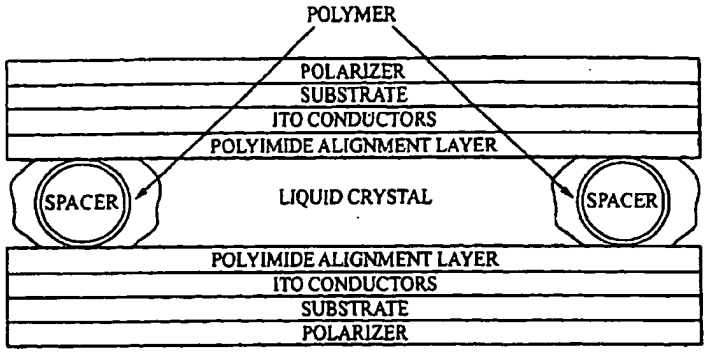
Primary Examiner—Tarifur R. Chowdbury
Assistant Examiner—David Y. Chung
(74) *Attorney, Agent, or Firm*—McGuireWoods LLP

(57) **ABSTRACT**

There is disclosed a liquid crystal display device comprising two substrates facing and spaced from each other, at least one of the substrates being transparent, electrodes positioned to establish an electric field in the space between the two substrates, one or more spacer elements located between the substrates, the spacer elements having been introduced between the substrates during assembly of the device, an electrooptic material filling at least a portion of the space between the two substrates, and a polymeric material filling at least a portion of the space between the substrates, the polymeric material comprising a liquid prepolymeric material that was applied to the spacer elements in liquid form and having been polymerized in situ after the spacer elements were in place between the substrate.

32 Claims, 3 Drawing Sheets



3. The method of claim 1, wherein the step of applying a pre-polymeric material to spacers comprises mixing spacers into the pre-polymeric solution in a concentration of about 1:2 wt/wt to form a pre-polymer/spacer mixture.

4. The method of claim 3, wherein the step of mixing comprises mixing the spacers in the pre-polymer solution via ultrasonic mixing.

Claim 3

5. The method of ~~claim 7~~, wherein the step of applying comprises spraying the pre-polymer/spacer mixture onto at one of the inner surface of the first substrate and the inner surface of the second substrate.

6. The method of claim 5, wherein the pre-polymer/spacer mixture is sprayed such that a surface density of the spacers is about 30 spacers/mm^2.

7. The method of claim 6, wherein the step of applying comprises using micro-filtered compressed nitrogen at approximately 10–30 psi is used as a propellant to spray the pre-polymer/spacer mixture onto at one of the inner surface of the first substrate and the inner surface of the second substrate.

8. The method of claim 7, further comprising adjusting at least one of pressure, viscosity of the pre-polymer/spacer mixture, relative concentrations of spacers and pre-polymeric material and nozzle orifice shape to achieve a pre-polymer coating individual spacers.

9. The method of claim 8, wherein either or both of the first substrate and the second substrate with the pre-polymer/spacer mixture is exposed to heat to remove solvents from the pre-polymer/spacer mixture.

10. The method of claim 9, further comprising curing the pre-polymer/spacer mixture.

11. The method of claim 8, wherein at least a portion of the spacers extend a distance between the inner surface of the first substrate and the inner surface of the second substrate.

12. The method of claim 1, further comprising coating, with a vapor barrier, an outside surface of the first substrate and an outside surface of the second substrate.

13. The method of claim 12, further comprising coating a layer of a transparent conductor on the first substrate and the second substrate, wherein the transparent conductor is patterned via at least one of chemical beam etching, electron beam etching and laser etching.

14. The method of claim 13, further comprising:

coating, with a polyimide solution, at least one of the first substrate and the second substrate coated with the transparent conductor; and

baking at least one of the first substrate and the second substrate to form a polyimide surface on thereon.

15. The method of claim 14, wherein the step of baking comprises baking the first substrate and the second substrate are baked for about one hour at a temperature of about 150° C.

16. The method of claim 14, further comprising rubbing the polyimide surface to develop an alignment layer for the liquid crystal cell.

17. The method of claim 1, further comprising surface etching glass spacers to create the spacers having polymerization initiating and/or enhancing (PIE) material on or therein.

18. The method of claim 17, wherein the step of surface etching glass spacers comprises surface etching glass spacers having a diameter of about 3 to about 3.5 μm.

19. The method of claim 17, wherein the step of surface etching comprises using about a 1.25% solution of hydrofluoric acid for about 10 minutes while suspended in a solution in an ultrasonic vibration tank.

20. The method of claim 17, further comprising coating, after washing, the etched spacers with a mixture of an adhesion promoter and at least one of the photoinitiator and the accelerator lacquer initiator by immersing the etched spacers into a solution containing the adhesion promoter and at least one of the photoinitiator, the accelerator initiator and an accelerant.

21. The method claim 20, wherein the adhesion promoter is a silane.

22. The method of claim 21, wherein the adhesion promoter is methacrylate silane.

23. The method of claim 22, wherein the accelerant is a tertiary amine.

24. The method of claim 23, wherein the tertiary amine is dimethyl amino benzene.

25. The method of claim 1, wherein the spacers comprise porous plastic and the PIE material is absorbed into the pores of the plastic.

26. The method of claim 1, wherein the spacers comprise high-surface area particles that are nanporous, mesoporous, or microporous.

27. The method of claim 1, wherein the solid polymeric material is at least one of an acrylic adhesive, epoxies and urethanes.

28. The method of claim 1, wherein the in solid polymeric material is an acrylic adhesive.

29. The method of claim 1, wherein the step of depositing a liquid crystal and pre-polymer mixture comprises depositing a liquid crystal and pre-polymer mixture comprising of about 10% photoinitiator and/or accelerator lacquer initiator pre-polymer and about 90% liquid crystal material.

30. The method of claim 1, wherein the flexible polymer material of the first substrate and the second substrate is polyethersulphone.

31. The method of claim 1, wherein the substrate has a glass transition temperature greater than 150° C.

32. The method of claim 1, wherein the step of laminating together the first substrate and the second substrate to form a liquid crystal cell is performed at about room temperature.

* * * * *

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Application No.	Filing Date	Attorney/Secretary Init
		TAF/rml

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21908 U.S. PTO
10/619409
07/15/03

Title of the Invention
ELECTROOPTICAL DISPLAYS CONSTRUCTED WITH POLYMER-COATED ELEMENTS POSITIONED BETWEEN SUBSTRATES

Applicant
Gary A. Freeman

Enclosures
·Transmittal Letter (2 pages)
·Patent Application (17 pages of specification, 8 pages of claims, 68 total claims, 1 pages of abstract)
·Check in the amount of $483.00
·Drawings (informal, 3 sheets)
·Combined Declaration and Power of Attorney (1 pages)
·Preliminary Amendment (7 pages)
·Other: Transmittal of Formal Drawings, 3 sheets

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APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: ELECTROOPTICAL DISPLAYS CONSTRUCTED WITH POLYMER-COATED ELEMENTS POSITIONED BETWEEN SUBSTRATES

APPLICANT: GARY A. FREEMAN

CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No. EV 331654346 US

July 15, 2003

Date of Deposit

Electrooptical Displays Constructed with Polymer-Coated Elements Positioned Between Substrates

Background of the Invention

This invention relates to liquid crystal and other electronic displays.

Commercially, it is highly desirable for an electronic display to be as thin and light as possible while still maintaining a high degree of ruggedness and imperviousness to forces that are a consequence of shock and drop. In the area of mobile electronics, such as cell phones and personal digital assistants (PDAs), size and weight are critical factors to the commercial success of a product, but currently breakage of the displays within these devices remains the primary cause of repairs and product returns. In addition, the need for electronic displays that can actually be bent has been acknowledged in several areas: so-called 'electronic paper' in which fiber paper is replaced with a display would be much more compelling as a product if the electronic display could be rolled up or folded like traditional paper; wearable electronics such as computers or multifunction watches would be much more comfortable to the wearer if the display were to conform to the user's body; chip cards which have strict flexure life-test performance standards would be able to incorporate flexible displays and still conform to those standards. Replacement of the glass substrates within displays with plastic film has been an area of active research within the display community for a number of years.

Electrophoretic displays achieve images via electrophoretics--the rapid migration of microparticles in colloidal suspensions. Light scattering particles are moved within a dyed colloidal suspension by electrostatic forces. The particles will either move toward the viewer, in which case, the typically white particles are seen by the viewer, or to the surface away from the viewer, in which case, the white particles will be hidden by the dark dye.

Cholesteric displays are another display technology being attempted on plastic substrates. When sandwiched between conducting electrodes, cholesteric liquid-crystal material can be switched between two stable states--the so-called focal conic and planar states--in which the liquid crystal's helical structures have different orientations. In the focal conic state, the helical structures are unaligned and the liquid crystal is transparent. In the

prepolymer in concentrations higher than what would be desired in regions of the display that are active image areas; the mixture is then deposited onto the substrate via printing or pipette methods into the interpixel regions or the perimeter where no image is presented, thus provided additional support without adversely affecting the image contrast or quality. The initiator may be solely heat activated or heat activated as well as photo-activated or other activation method. The polymer is chosen so as to contract following initial bonding to the substrates and upon curing; the two substrates are thus drawn together, increasing durability of the display; this is particularly effective when the polymer is localized around the spacer element, as has been previously described. The spacer element may be one or more sheets of an extensible porous membrane that when laminated in between the substrates is the element that determines the spacing between the substrates. One or more of the substrates may be of glass or other rigid material.

Other embodiments of the invention are within the following claims.

What is claimed is:

1. A liquid crystal display device, comprising:

two substrates facing and spaced from each other, at least one of the substrates being transparent;

electrodes positioned to establish an electric field in the space between the two substrates;

one or more spacer elements located between the substrates, the spacer elements having been introduced between the substrates during assembly of the device;

an electrooptic material filling at least a portion of the space between the two substrates; and

a polymeric material filling at least a portion of the space between the substrates, the polymeric material comprising a liquid prepolymeric material that was applied to the spacer elements in liquid form and having been polymerized in situ after the spacer elements were in place between the substrates.

2. A method of manufacturing a liquid crystal display device, comprising:

introducing spacer elements between two substrates that face each other, at least one of the substrates being transparent;

applying a liquid prepolymeric material to the exterior surfaces of one or more spacer elements before or after introduction of the spacer elements between the substrates;

positioning electrodes to establish an electric field in the space between the two substrates;

filling at least a portion of the space between the two substrates with an electro-optic material; and

polymerizing the liquid prepolymeric material in situ to form solid polymeric material filling at least a portion of the space between the substrates.

3. The subject matter of claim 1 or 2 wherein the polymeric material is in the vicinity of the spacer elements.

4. The subject matter of claim 1 or 2 wherein the liquid prepolymeric material is applied to the spacer elements prior to their introduction between the substrates.

5. The subject matter of claim 1 or 2 wherein the liquid prepolymeric material is applied to the spacer elements after their introduction between the substrates.

6. The subject matter of claim 3 wherein the liquid prepolymeric material is encased in a collapsible shell surrounding at least some of the spacer elements.

7. The subject matter of claim 1 or 2 wherein the liquid prepolymeric material comprises one or more of the following: monomer, oligomer, inhibitor, adhesion promoter, polymerization initiating or enhancing (PIE) material.

8. The subject matter of claim 1 or 2 wherein the liquid prepolymeric material has a viscosity equal to or less than 2,000,000 centipoise.

9. The subject matter of claim 1 or 2 wherein a polymerization initiating or enhancing (PIE) material is brought into contact with the liquid prepolymeric material.

10. The subject matter of claim 9 wherein the PIE material is brought into contact with the liquid prepolymeric material in one of the following ways: it is mixed with the liquid prepolymeric material applied to the spacer elements; it is carried on or within the spacer elements; it is dissolved or suspended in the electrooptic material.

11. The subject matter of claim 10 wherein the liquid prepolymer material and the PIE material are both encased in a collapsible shell surrounding at least some of the spacer elements.

12. The subject matter of claim 9 wherein the polymerization in-situ comprises initiating polymerization by application of light.

13. The subject matter of claim 1 or 2 wherein the liquid prepolymeric material is a thermoset material, and the polymerizing in situ comprises the application of heat.